Base from U.S. Geological Survey, 1956

Geology by A.T. Fernald, 1952; G.H. Pessel and W.P. Brosgé, 1966-1974; SCALE 1:250 000 LOCATION INDEX CONTOUR INTERVAL 200 FEET DATUM IS MEAN SEA LEVEL QUADRANGLE LOCATION CORRELATION OF MAP UNITS Sand and silt lacustrine deposits deposits Mountain glaciation Holocene (Neoglaciation) glaciation QUATERNARY glaciation - Pleistocene Sagavanirkto

SURFICIAL GEOLOGIC MAP OF THE AMBLER RIVER QUADRANGLE, ALASKA

Thomas D. Hamilton

Surficial geologic mapping of the Ambler River quadrangle was based on study of (1) morphology, composition, distribution, and interrelations of unconsolidated deposits; (2) sediments and soil profiles in auger borings and test pits; (3) exposures along lake shores and river bluffs; and (4) previously published geologic maps and reports (for example: Smith, 1913; Smith and Mertie, 1930; Pessel and Brosgé, 1977; Mayfield and Tailleur, 1978). The map units are defined on the basis of their character, age, and genesis; most are identical to units employed previously on other surficial geologic maps of the central Brooks Range (Hamilton, 1978a, 1978b, 1979a, 1979b, 1980, 1981,

The basic stratigraphic framework for the surficial units is provided by the central Brooks Range glacial sequence of Detterman and others (1958), with modifications by Porter (1964), Hamilton and Porter (1975), and Hamilton 1978c, 1979c, 1982). Drift limits within the Ambler Lowland generally coincide with those of Fernald (1964), and nis glacial succession is correlated with that of the central Brooks Range as follows:

Central Brooks Range Modern glaciation Ulaneak Creek glaciation (Walker Lake glaciation Walker Lake glaciation

Pleistocene < Ambler glaciation

(Kobuk glaciation

Drifts of only three middle and late Pleistocene glacial advances are recognized within the Ambler River quadrangle; but multiple older drifts of Pleistocene and Tertiary(?) age occur farther to the south within the Shungnak and Hughes quadrangles (Hershey, 1909; Hamilton, 1969) as well as to the north in the Howard Pass quadrangle (Hamilton, 1984). Drift of the Sagavanirktok River glaciation is strongly modified by later weathering, mass wastage, and stream erosion. This glaciation was separated from the subsequent ice advances of Itkillik and Walker Lake age by a long interglacial interval (Hamilton and Hopkins, 1982).

Sagavanirktok River glaciation

Usage of the term "Itkillik glaciation" differs from that of prior surficial geologic maps in the central Brooks Range series. Hamilton and Porter (1975) divided the Itkillik glaciation of Detterman (1953) into phases termed Itkillik I and II", and these were represented in the previous maps by units id, and id, and by related meltwater deposits. Field mapping during 1974-1982, however, showed that Itkillik I and II deposits are morphologically distinct in most valleys of the central Brooks Range and clearly were separated by a long-lasting nonglacial interval of weathering, soil formation, mass wastage, and stream incision. Radiocarbon dates confirm the age separation. Itkillik I deposits generally predate 53,000 radiocarbon yr B.P. (before present), and Itkillik phase I glacial expansion clearly coincided in time with the span of late Wisconsin glaciation (24,000 to 10,000 yr B.P.) in the standard North American glacial sequence (Hamilton, 1982). Because Itkillik I and II deposits are clearly separable in age and morphology, the phase I and II designations are no longer employed (Hamilton, 1982). The term Itkillik" is retained for the older deposits that formerly were termed "phase I"; younger deposits formerly designated "phase II" are reassigned to the Walker Lake glaciation of Fernald (1964).

At its type locality, drift of Fernald's (1964) Ulaneak Creek glaciation contains weathered and frost-shattered stones, many of which have been reduced to the level of the general ground surface. Soil profiles contain oxidized horizons 28 cm or more in thickness. Distribution and character of these deposits are similar to those of deposits of late Walker Lake age farther east in the Brooks Range, consequently much of the drift mapped as Ulaneak Creek must represent recessional deposits or minor glacial readvances of glaciers rather than a separate Holocene glacier advance. The term "Ulaneak Creek" should no longer be used to refer to these deposits.

The complex surficial geology of the Ambler River quadrangle reflects multiple source areas for glacier accumulation in the western Brooks Range and the blockage of the westward-flowing Kobuk and Noatak Rivers by south-flowing valley glaciers. Extensive glaciolacustrine deposits formed in the Kobuk valley during Sagavanirktok River time, probabl because of an ice dam at the mouth of the Squirrel River about 60 km west of the Ambler River quadrangle. Drift exposures of Sagavanirktok River age near the mouths of the Hunt and Ambler rivers include deltaic deposits and glaciolacustrine clays containing abunidant dropstones; these deposits indicate that glaciers and outwash trains extended southward from the Brooks Ranige into a large lake that filled the center of the Kobuk valley. Sandy deltaic sediments later were reworked by wind and by streams during Itkillik and Walker Lake times, forming extensive sand sheets, sand aprons, and dune fields. During at least three advances of middle and late Pleistocene age, glaciers from the Delong Mountains flowed southeast, blocking the Noatak River and forming a large proglacial ake (glacial Lake Noatak: Hamilton and Ashley, 1983). Extensive glaciers of Sagavanirktok River age confined the glacial lake on the south, east, and west sides, forcing it to discharge northward. The lake later attained its greatest surface area (about 4,400 km²¹) and depth (about 200 m) during the Itkillik glaciation. The youngest lake dating from the Walker Lake glaciation, was smaller (about 1,600 km²), elongate, and confined to the center of the Noatak Valley and the lower valley of the Cutler River.

The largest glacier of Itkillik age originated near the head of the Noatak valley and flowed westward, extending about 75 km into the Ambler River quadrangle. Other long (45-60 km) valley glaciers accumulated near valley heads within the eastern half of the map are:a. These ice bodies formed individual glacier tongues in the southern valleys and to the north formed tributaries to) the Noatak valley glacier. Much shorter (2-7 km) glaciers were generated in low-lying valley heads of the Baird Movuntains in the Western half of the map area. A large glacier flowed southeast from the source areas in the De Long Mountins, extending about 35 km into the Ambler River quadrangle from its northwest corner and damming glacial Lake Noatak. The isostatically-warped surface of this lake stage rises eastward in an altitude from 425 m near its west limit to 525 m near the east margin of the basin.

Glaciers were much smaller during Walker Lake time and attained lengths of several tens of kilometers only in the easternmost valleys of the Ambler River quadrangle. Ice tongues extended to the south flank of the Brooks Range only along the valleys of Shungmak and Kogoluktuk Rivers. Glaciers in four northern valleys were tributary to the Noatak valley glacier, which extended 35 km westward into the Ambler River quadrangle. Glaciers farther west were restricted to cirques and upper valley:s; most were only 1-2 km long. A large glacier from the Delong Mountains gain flowed southeast to block the Novatak valley, terminating about 1 km northwest of the map area. The Walker Lake stage of glacial Lake Noatak stood at 340 m asl (above sea level) near the ice dam and 375 m farther to the

Glacier and rock-glacier activity assignable to the late Holocene Fan Mountain glaciation of Detterman and others (1958) was negligible except in the extreme east-central part of the Ambler River quadrangle. For distribution and thronology of the more extensive Fan Mountain glaciation east of the map area, see Hamilton (1981) and Ellis and

Permafrost is present in most of the Ambler River quadrangle. Depth of its upper surface varies from 15-30 cm in muskeg areas to 0.5 m or more in permeable or coarsed-grained sediments. Although thicknesses are unknown, records from other parts of the Brooks Range (for example, Ferrians, 1965; Williams, 1970, p. 31-32) suggest that the base of permafrost may lie at depths of 100 ±50 m in much of the map area.

The Ambler River quadrangle differs from regions farther east in the Brooks Range in that large areas of the major lley floors are covered by glaciolacustrine sediments and eolian, fluvial, and lacustrine sand. The laciolacustrine deposits that fill the Noatak valley have been assigned to glacial lakes of Walker Lake, Itkillik and Sagavanirktok River age on the basis of their interrelations with the moraines that border the lake basin. The sand deposits that fill the Kobuk valley are subdivided into younger and older units that may have formed during glacial advances of Walker Lake and Itkillik age. Thin sheets of the older sand, which are shown as composite units sa<sub>1</sub>/sd and sa<sub>1</sub>/so) on the map, cover end moralnes and outwash of Sagavanirktok River age near the mouth of Hunt River. Sand reworked by the wind was deposited as active and inactive dunefields south of the Kobuk River and as sloping aprons banked against the lower slopes of uplands that surround the Kobuk Valley.

### DESCRIPTION OF MAP UNITS

DEPOSITS OF STEEP ALPINE FANS--Coarse, very poorly sorted, nonstratified to weakly stratified, subangular to subrounded, silty-sandy gravel at mouths of avalanche chutes and steep canyons near heads of mountain valleys. Upper segments generally channeled, with levees of angular to subangular coarse debris. Subject to snow avalanches during winter (Luckman, 1978), slushflows during spring snowmelt (Washburn, 1980, p. 193-195), and debris flows during summer (Rapp and Nyberg, 1981). Surface gradients generally 12°-25°, intermediate between those of alluvial fans and talus cones

Subunit  $af_{i}$  designates inactive alpine-fan deposits, as described above; generally weathered and covered with sod and vegetation. Most are periglacial features that formed beyond limits of ice advances of Walker Lake or

FAN DEPOSITS--Range from very poorly sorted, weakly stratified, subangular, silty-sandy, coarse gravel at mouths of steep canyons to moderately sortedi and stratified, subrounded, sandy gravel at mouths of large tributary valleys with relatively gentle gradients. Locally subject to icings during winter (Sloan and others, 1976 Subunit fi designates inactive fan deposits, as described above; generally weathered and covered with sod and vegetation. Most formed beyond limits of ice advance of Itkillik age in south-trending valleys within

FAN-DELTA DEPOSITS--Alluvial-fan facies (poorly sorted, weakly stratified, subangular, sandy gravel) near valley walls, grading into deltaic and lacustrine facies (well-sorted and well-stratified silt, sand, and fine gravel) near valley centers. Occur in moraine-dammed basins within valleys of Noatak and Redstone Rivers and Kalurivik Creek

OTHER ALLUVIAL DEPOSITS ALLUVIUM, UNDIVIDED--Varies from poorly sorted, moderately well stratified, subangular, coarse gravel near heads of mountain valleys to moderately well sorted gravelly sand and sandy fine gravel along slow-flowing stretches of major streams. May contain local beds and lenses of sand and sandy silt. Includes fan, flood-plain, and low terrace deposits too small to be designated separately

MODERN ALLUVIUM--Gravel and sandy gravel, as described above; generally unvegetated and commonly subject to icings within mountain valleys. Differentiated only along major streams LOW ALLUVIAL TERRACE DEPOSITS--Gravel and sandy gravel, as described above; mantled with 0.3-1 m of silt, sand, or

peat, typically vegetated, and forming terraces generally within 3-4 m of modern stream levels. Differentiated al-sa ALLUVIUM, SAND FACIES--Moderately sorted to well-sorted, fine to medium sand, parallel bedded to slightly crossbedded, commonly with thin interbeds of sandy peat or organic silty fine sand. Deposited initially by slow-moving streams

ithin basins partly dammed by end moraines in valleys of Noatak, Cutler, Amakomanak, Redstone, Shungnak, and

Kogoluktuk Rivers and Kalurivilk Creek. Upper 1-2 m locally reworked by wind into sand sheets and dunes. Commonly

grades downward into lacustrine deposits (see stippled map pattern). TERRACE GRAVEL, UNDIVIDED--Gravel, sandy gravel, and gravelly sand, forming alluvial terraces of post-Itkillik age along Hunt, Shungnak, and Ambleer Rivers and of both post-Itkillik and post-Walker Lake age along the Noatak River. Occupy intermediate levels below till and outwash surfaces and above Holocene flood plains. Represent stages in downcutting through thick drift deposits

GRAVEL DEPOSITS, UNDIVIDED--Gravel and sandy gravel of diverse origins and composition within Noatak valley. Typically wave-eroded lag conceentrates formed from glacial deposits

# COLLUVIAL DEPOSITS

LANDSLIDE DEPOSITS--Unsorted, nonsttratified, coarse to fine, angular rubble, commonly with matrix of finer debris, forming lobes below detachment scars and slide tracks on high steep rock walls. Subject to episodes of rapid downslope motion and long periods of relative stability. Most common on schist (15 of 32 occurrences) as mapped by Mayfield and Tailleur (1978)); six other landslides occur on the Skajit Limestone. Only three (9 percent) occur on or near faults as mapped by Mayfield and Tailleur (1978).

Subunit (1s) designates incipieent landslides marked by fractured and sagging rock masses on mountain slopes FLOW-SLIDE DEPOSITS--Very poorly scorted, angular, tabular rubble in abundant matrix of generally micaceous sand and silt containing little clay. Fforms lobes subject to slow and probably continuous downslope motion. Most common

on schist near south margin of Brooks Range TALUS RUBBLE, ACTIVE--Angular unsorrted nonstratified rock debris forming cones and aprons more than 2 m thick and generally sloping 30°-33° along lower flanks of mountain valleys and on cirque headwalls. Also forms thinner and generally discontinuous sheets over many uplands mapped as bedrock. Generally unvegetated, unweathered to

slightly weathered, with lichern cover sparse to absent. Subject to rockfalls from slopes above, especially during

spring thaw (Porter and Orombellli, 1981) tr; TALUS RUBBLE, INACTIVE--Angular rockk debris, as described above, generally weathered and lichen covered, with partial sod cover at some localities. Thin (less than 1.5 m) blankets of stabilized talus occur in uplands mapped as bedrock in western part of map area

sf SOLIFLUCTION DEPOSITS--Very poorly sorted, nonstratified to weakly stratified, stony silt and organic silt in sheets and aprons more than 1-2 m thicck on gentle to moderate slopes. Platy to elongate stones generally oriented parallel to slope. Most commonn beyond outer limits of Itkillik drift; locally present on deposits of Itkillik age. The 56 mapped 'solifluction deposits show little correlation with bedrock lithology as mapped by Mayfield and Tailleur (1978). Fourteen of the deposits (25 percent) occur on or near mapped faults Subunit (sf) designates thin (Ress than 1.5 m) and discontinuous solifluction deposits above bedrock in northwest

COLLUVIUM, UNDIVIDED -- Mixed talus rubble and solifluction deposits, as described above, in sheets and aprons more than 1-2 m thick. Most common on moderate to steep slopes above and beyond limits of ice advances of Itkillik age COLLUVIUM OF MOUNTAIN VALLEYS -- Inactive talus rubble and thin solifluction deposits on upper slopes; grading downward into solifluction aprons and imactive talus cones on lower slopes. Alluvium intergrades with talus rubble,

Cutler River, Natmotirak Creek, Cross Creek, Amakomanak Creek, and their tributaries. Not present in valleys through which ice advanced during Itkillik time AVALANCHE TRACKS AND DEPOSITS--Angular unsorted nonstratified loose rock debris; forms tongues and fans along lower walls of mountain valleys (Luckman, 1978). Associated with tracks or chutes where soil and vegetation are generally absent. Present only within deeper valleys in east half of map area

Geologic-climate units (glaciatioms, interglaciations, stades, and interstades), defined in the previous stratigraphic code (American Commission on Stratigraphic Nomenclature, 1970. p. 31), have been abandoned by the North American Commission on Stratiigraphic Nomenclature (1983, p. 849) and are now recognized as informal units. Inferences regarding climate are subjective and have proved to be too tenuous a basis for the definition of formal

solifluction deposits, and rubble from near-surface bedrock along the valley centers. Most common near heads of

rga ROCK-GLACIER DEPOSITS, ACTIVE--Very poorly sorted, nonstratified, coarse, angular rock debris with matrix of silt and fine rubble; contains abundant interstitial ice. Upper surfaces generally unvegetated, unweathered to moderately unweathered, with sparse lichen cover. Frontal slopes barren, steep (350-380), and highly unstable, meeting upper surfaces at abrupt angle. Fed by talus cones and aprons, which commonly are too small to show on map. Form (1) lobate deposits at base of talus cones along valley walls and (2) tongue-shaped deposits within cirques (see White, 1976). Tongue-shaped variety commonly overlies stagnant glacier ice (Ellis and Calkin, 1979). Subject to slow downslope motion. Most commonly present near valley heads in east half of map area

ROCK-GLACIER DEPOSITS, INACTIVE--Coarse angular rock debris, as described above, but without interstitial ice. Upper surfaces and frontal slopes weathered and lichen covered, commonly with partial cover of sod or vegetation. Frontal slopes grade into upper surfaces without abrupt angles

PROTALUS RAMPART DEPOSITS--Unsorted nonstratified coarse angular rock debris forming arcuate low ridges at bases of steep slopes. Occur at toes of persistent snowbanks in shaded sites. Subject to rockfalls from slopes above during spring thaw. Occur only near valley heads near east margin of map

# SAND AND SILT DEPOSITS

SAND DEPOSITS -- Moderately sorted fine to medium sand, horizontally bedded to slightly crossbedded; commonly has thin interbeds of sandy peat or organic silty fine sand. Forms terraces 5-10 m high within basins partly dammed behind end moraines in Noatak, Kogoluktuk, and Kalurivik valleys and in valley of Miluet Creek. Similar deposits in valleys of Hunt and Akillik Rivers formed in response to general alluviation of Kobuk valley during Itkillik and Walker Lake glaciations

YOUNGER SAND DEPOSITS--Very fine to fine sand, containing some medium sand, with bedding features as described above. Stand 10-20 m above modern stream levels. Deposited as broad sheets across Kobuk valley and Ambler Lowland by slow-moving streams that received heavy sand loads of glacial and eolian origin during Walker Lake

OLDER SAND DEPOSITS--Fine to medium sand, as described above. Stand 30-50 m above levels of modern large streams. Filled Kobuk valley and lower courses of its tributaries during Itkillik glaciation as proglacial deposits of Composite units  $sa_1/sd$  and  $sa_1/so$  designate older sand deposits above till and outwash of Sagavanirktok River age

SAND APRONS--Very fine to fine sand. Forms smoothly sloping, wedge-like, tundra-covered deposits that extend to heights of 100-250 m against flanks of uplands bordering Kobuk valley and Ambler Lowland. Winnowed, transported, and deposited by wind from areas of bare sand (active dunes and flood plains) along valley floor during Itkillik ds DUNE SAND, ACTIVE--Moderately to well sorted, yellowish, medium to fine sand with some interbeds of coarse sand;

southwest corner of map and narrow belts of foredunes along south bank of Kobuk River opposite mouth of Hunt River. The transverse dunes were built mainly by downvalley (easterly) winds; the foredunes by katabatic winds ds DUNE SAND, INACTIVE--Medium to fine sand, as described above, with vegetated surfaces and well-developed to weakly developed soil profiles. Forms extensive fields of forested parabolic dunes south of Kobuk River near southwest

parallel bedded to steeply crossbedded. Forms extensive fields of transverse dunes south of Kobuk River near

us UPLAND SILT DEPOSITS--Poorly to moderately sorted, generally unstratified silt, organic silt, and slightly clayey, sandy, or stony silt on uplands of low to moderate relief in northwest quarter of map. Formed from loess and mixed with local organic matter and weathering products by frost action. Generally has tussock cover broken by frost boils. Grades laterally into solifluction deposits on slopes steeper than about 10-20

THAW-LAKE DEPOSITS--Weakly stratified to nonstratified silt, organic silt, and clayey to sandy silt; generally contains abundant ice in form of lenses, wedges, and interstitial grains. Fills widespread thaw basims on glacial lake deposits along floor of Noatak valley in northwest quarter of map

#### GLACIAL DEPOSITS Fan Mountain glaciation (Neoglaciation)

nd FAN MOUNTAIN DRIFT, UNDIVIDED--Unsorted, nonstratified, coarse to fine, angular rubble in cirques near valley heads within eastern one-third of map area. Designates remnants of eroded drift unassignable to either phase I or phase II of Fan Mountain glaciation

nd, DRIFT OF FAN MOUNTAIN PHASE II--Unsorted, nonstratified, coarse to fine, angular rubble forming ice-cored lobes and arcuate ridges that have steep unstable frontal slopes. Unvegetated, unweathered to slightly weathered, with lichens sparse to absent. Restricted to cirques and generally associated with modern glaciers nd DRIFT OF FAN MOUNTAIN PHASE I--Angular rubble, as described above, forming more subdued lobes and ridges with stable

frontal slopes; generally eroded by axial streams. Weathered and lichen encrusted; has partial (about 30-50 percent) sod cover in most localities Walker Lake and Itkillik glaciations

d DRIFT, UNDIVIDED--Unsorted to poorly sorted, generally nonstratified compact till ranging in composition from muddysandy gravel to gravelly-muddy sand, containing local stratified ice-contact deposits that consist of moderately sorted sand and sandy gravel. Contains faceted and striated stones as big as large boulders. Designates thick (>3 m) and discontinuous drift deposits, generally within mountain valleys, that may be of either Walker Lake or

DRIFT OF WALKER LAKE AGE--Till and stratified ice-contact deposits, as described above. Forms sharply defined arcuate drift belts with narrow-crested (generally 1-3 m) moraines, prominent knob and kettle morphology, and conspicuously channeled outwash trains. Crests and upper slopes bear no loess or solifluction cover, and exposed boulders are slightly to moderately weathered; oxidation has penetrated 40-50 cm into well drained deposits. Most swales have no solifluction deposits, and abandoned meltwater channels commonly are floored with thin sod mats Subunit wk (KAME AND KAME-TERRACE DEPOSITS) designates thick and extensive sand and gravel deposits, as described

wd2 DRIFT OF LATE WALKER LAKE AGE--Till and stratified ice-contact deposits, as described above. Form sharp-crested end moraines 3-5 km beyond cirques in mountain valleys in southeast quarter of map. Loess cover absent to thin (<0.2 m thick), and exposed stones very slightly weathered; oxidation has penetrated only 20-30 cm into well drained id DRIFT OF ITKILLIK AGE--Till and stratified ice-contact deposits, as described above. Moraine crests generally 5-10 m

wide and partly bare of loess; upper slopes blanketed by stony organic silt (loess and colluvium) 0.5-2 m thick; swales filled with deposits of ice-rich organic silt 2-5 m thick. Form extensive hummocky drift bodies with subdued morphology beyond limits of Walker Lake drift in Noatak valley, along south flank of Brooks Range east of Hunt River, and near heads of tributary valleys in Hunt River drainage system Subunit (id) designates drift of Itkillik age that has been mixed with silt, rock rubble, and organic detritus on hill slopes or lower valley walls and has become a compound (glacial-colluvial) deposit

Subunit (ik) (KAME AND KAME-TERRACE DEPOSITS) designates unusually thick and extensive gravel deposits, as described above, in drift of Itkillik age in Noatak and Imelyak valleys DRIFT OF LATE ITKILLIK AGE--Till and stratified ice-contact deposits, as described above. Forms separate inner

moraines in Noatak valley in north-central and northwestern parts of map area DRIFT OF EARLY ITKILLIK AGE--Till and stratified ice-contact deposits, as described above. Forms separate outer moraines in Noatak valley in north-central and extreme northwestern parts of map area Subunit  $ik_A$  (KAME AND KAME-TERRACE DEPOSITS) designates thick and extensive sand and gravel deposits, as described

above, associated with drift of early Itkillik age north of Noatak River near head of Atongarak Creek WALKER LAKE OUTWASH--Moderately well sorted and stratified sandy gravel forming terraces up to about 30 m high in front of Walker Lake moraines; also present as isolated terrace remnants farther downvalley. Largest stones decrease in size from rounded to subrounded cobbles and very small boulders near moraine fronts to rounded pebbles

and small cobbles farther downvalley OUTWASH OF LATE WALKER LAKE AGE--Sandy gravel, as described above, generally without loess or peat cover and oxidized to a depth of only 20-30 cm. Forms fans downslope from drift of late Walker Lake age in mountain-valley

ITKILLIK OUTWASH--Sandy gravel, as described above; usually has thick (0.5-4 m) widespread cover of silt, organic silt, and peat. Forms valley trains and aprons in front of Itkillik end moraines. Commonly grades downvalley into thick sandy basin-fill deposits or silty glaciolacustrine deposits OUTWASH OF LATE ITKILLIK AGE--Sandy gravel, as described above, associated with end moraines of late Itkillik age in

io OUTWASH OF EARLY ITKILLIK AGE--Sandy gravel, as described above, associated with end moraine of early Itkillik age in INWASH OF WALKER LAKE AGE--Well to moderately well sorted and stratified gravelly sand and sandy fine grave:1, commonly

grading upvalley into sandy gravel. Deposited near mouths of nonglaciated tirbutaries blocked by glaciers of Walker Lake age in valleys of Midas Creek and Imelyak River. Forms benches and terraces that abut outer flanks of lateral moraines or outer faces of drift lobes INWASH OF ITKILLIK AGE--Gravelly sand and sandy gravel, as described above, forming terraces that abut drift of

Itkillik age in valleys of Redstone, Kogoluktuk, and Noatak Rivers and Anakomanak Creek INVASH OF LATE ITKILLIK AGE--Gravelly sand and sandy gravel, as described above, forming terraces that abut drift of late Itkillik age along north side of Noatak valley

INWASH OF EARLY ITKILLIK AGE--Gravelly sand and sandy gravel, as described above, forming terraces that abust drift of

early Itkillik age along north side of Noatak valley Sagavanirktok River glaciation sd SAGAVANIRKTOK RIVER DRIFT--Poorly sorted nonstratified till, probably ranging in composition from silty-sandy-bouldery gravel to clayey-stony silt, and containing local deposits of moderately well sorted and stratified gravel.

enerally covered by thick (more than 2-3 m) blanket of nonstratified to weakly stratified silt, stony silt, clayey silt, and organic silt (loess, solifluction, glaciolacustrine, and muskeg deposits, respectively), but crests of some ridges and knolls yield limited exposures of weathered gravel consisting of subrounded prebbles, cobbles, and small boulders of resistant lithologies. Occurs beyond limits of Itkillik drift in Noatak valley, Kobuk valley, and Ambler River Lowland. Composite unit  $sa_1/sd$  designates Sagavanirktok River drift, as described above, beneath thick sand deposits near

mouth of Hunt River

DRIFT OF LATE SAGAVANIRKTOK RIVER AGE--Till and stratified ice-contact deposits, as described above. Forms inner moraine belts within drift complexes near mouths of Ambler and Cutler Rivers

DRIFT OF EARLY SAGAVANIRKTOK RIVER AGE--Till and stratified ice-contact deposits, as described above. Forms outer moraine belts within drift complexes near mouths of Ambler and Cutler Rivers. Generally more dissected and more subdued by mass wastage than deposits of unit sdo SAGAVANIRKTOK RIVER OUTWASH--Moderately well sorted and stratified sandy gravel forming trains and aprons beyond drift of Sagavanirktok River age. Stones generally weathered; matrix generally oxidized to brown colors. Most

extensive at south flank of Jade Mountains; also occurs as high-level (>100 m) terrace remnants along Shungnak Subunit (80) designates thin and patchy remnants of Sagavanirktok River outwash on erosion surface near mouth of

Composite unit  $sa_1/so$  designates Sagavanirktok River outwash, as described above, beneath thick sand deposits near

#### GLACIOLACUSTRINE DEPOSITS LACUSTRINE DEPOSITS--Well-stratified clay, silt, and sand along Ambler River near Lake Anirak. Shown elsewhere by

stippled map pattern where buried beneath alluvium, sand sheets, or solifluction and fan deposits WALKER LAKE GLACIOLACUSTRINE DEPOSITS -- Stony silt and stony-clayey silt, massive to faintly bedded, containing sparse to abundant subangular to subrounded pebbles, cobbles, and small boulders that commonly are striated. Widespread across floor of Noatak valley and lower Cutler valley below altitudes that rise from 340 m in the west to 375 m in the east. Confined by glacier that blocked Noatak valley just beyond northwest corner of map

ITKILLIK GLACIOLACUSTRINE DEPOSITS--Stony silt and stony-clayey silt, as described above. Widespread across entire floor of Noatak valley between end moraines of Itkillik age. Maximum altitudes rise from 425 m in the west to 525 m in the east. Confined by glacier that blocked Noatak valley in northwest corner of map. Also occurs along Ryan Creek on north flank of Asbestos Mountain

GLACIOLACUSTRINE DEPOSITS OF YOUNGER ITKILLIK AGE -- Stony silt and stony-clayey silt, as described above, that occurs within outermost moraines of Itkillik age in valleys of Imelyak River and Amakomanak Creek SAGAVANIRKTOK RIVER GLACIOLACUSTRINE DEPOSITS--Stony silt and stony-clayey silt, as described above, but more heavily dissected by postglacial stream erosion. Maximum altitudes about 500 m near west margin Noatak basin. Also occurs southeast of Jade Mountains at south margin of drift lobe of unit sd2

REFERENCES CITE

American Commission on Stratigraphic Nomenclature, 1970, Code of Stratigraphic Nomenclature (2nd edition): Tulsa, Oklahoma, American Association of Petroleum Geologists, 45 p. Detterman, R. L., 1953, Sagavanirktok-Anaktuvuk region, northern Alaska, in Péwé, T. L., and others, eds., Multiple glaciation

Detterman, R. L., Bowsher, A. L., and Dutro, J. T., Jr., 1958, Glaciation on the Arctic Slope of the Brooks Range, northern Alaska: Arctic, v. 11, p. 43-61.

in Alaska: U.S. Geological Survey Circular 289, p. 11-12

Ellis, J. M., and Calkin, P. E., 1979, Nature and distribution of glaciers, Neoglacial moranies, and rock glaciers, eastcentral Brooks Range, Alaska: Arctic and Alpine Research, v. 11, p. 403-420. 1984, Holocene glaciation of the Brooks Range: Geological Society of America Bulletin [in press].

Fernald, A. T., 1964, Surficial geology of the central Kobuk River valley, northwestern Alaska: U.S. Geological Survey Bulletin 1181-K, p. K1-K31. Ferrians, O. J., 1965, Permafrost map of Alaska: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-445, scale

Hamilton, T. D., 1969, Glacial geology of the lower Alatna Valley, Brooks Range, Alaska, in Schumm, S. A., and Bradley, W. C., eds., United States contributions to Quaternary research: Geological Society of America Special Paper 123, p. 181-223.

1978a, Surficial geologic map of the Chandalar quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies 1978b, Surficial geologic map of the Philip Smith Mountains quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-879-A, scale 1:250,000.

1978c, Late Cenozoic stratigraphy of the south-central Brooks Range, in Johnson, K. M., ed., The United States Geological Survey in Alaska - Accomplishments during 1977: U.S. Geological Survey Circular 772-B, p. B36-B38.

1979a, Surficial geologic map of the Chandler Lake quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-1121, scale 1:250,000. 1979b, Surficial geologic map of the Wiseman quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map

1979c, Late Cenozoic glaciations and erosion intervals, north-central Brooks Range, in Johnson, K. M., and Williams, J. R., eds., the United States Geological Survey in Alaska - accomplishments during 1978: U.S. Geological survey Circular

1980, Surficial geologic map of the Killik River quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies Map MF-1234, scale 1:250,000. 1981, Surficial geologic map of the Survey Pass quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies

significance: Geological Society of America Bulletin, v. 93, p. 700-716. 1984, Surficial geologic map of the Howard Pass quadrangle, Alaska: U.S. Geological Survey Miscellaneous Field Studies

1982, A late Pleistocene glacial chronology for the southern Brooks Range - Stratigraphic record and regional

Hamilton, T. D., and Ashley, G. M., 1983, Glacial Lake Noatak, northwestern Alaska--Paleogeography, history, and environmental implications: Geological Society of America Abstracts with Programs, v. 15, p. 590. Hamilton, T. D., and Hopkins, D. M., 1982, Correlation of northern Alaskan glacial deposits--A provisional stratigraphic framework, in Coonrad, Warren, ed., The United States Geological Survey in Alaska - Accomplishments during 1980: U.S.

Geological Survey Circular 844, p. 15-18. Hamilton, T. D., and Porter, S. C., 1975, Itkillik glaciation in the Brooks Range, northwestern Alaska: Quaternary Research,

Hershey, O. H., 1909, The ancient Kobuk glacier of Alaska: Journal of Geology, v. 17, p. 83-91. Luckman, B. H., 1978, Geomorphic work of snow avalanches in the Canadian Rocky Mountains: Arctic and Alpine Research, v. 10,

Mayfield, C. F., and Tailleur, I. L., 1978, Bedrock geologic map of the Ambler River quadrangle, Alaska: U.S. Geological Survey Open-File Report 78-120A, scale 1:250,000. North American Commission on Stratigraphic Nomenclature, 1983, North American Stratigraphic Code: American Association of Petroleum Geologists Bulletin, v. 67, p. 841-875.

Porter, S. C., and Orombelli, Giuseppe, 1981, Alpine rockfall hazards: American Scientist, v. 69, p. 67-75. Rapp, Anders, and Nyberg, Rolf, 1981, Alpine debris flows in northern Scandanavia--Morphology and dating by lichenometry:

Pessel, G. H., and Brosgé, W. P., 1977, Preliminary reconnaissance geologic map of Ambler River quadrangle, Alaska: U.S.

Sloan, C. E., Zenone, Chester, and Mayo, L. E., 1976, Icings along the trans-Alaska pipeline route: U.S. Geological Survey

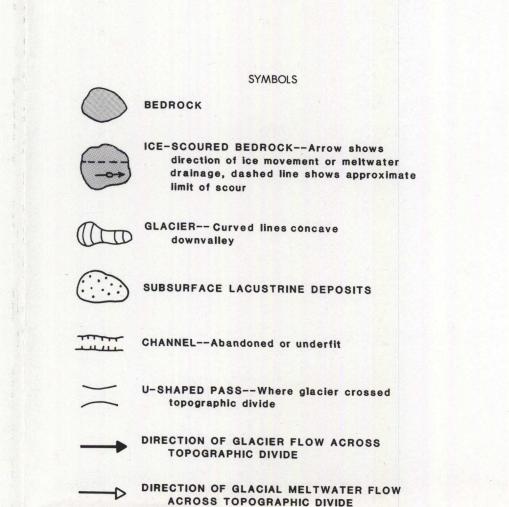
Geological Survey Open-File Map OF 77-28, scale 1:250,000.

Geografiska Annaler, v. 63A, p. 183-196.

Smith, P. S., 1913, The Noatak-Kobuk region, Alaska: U.S. Geological Survey Bulletin 536;, 160 p. Smith, P. S., and Mertie, J. B., Jr., 1930, Geology and mineral resources of northwestern Alaska: U.S. Geological Survey Washburn, A. L., 1980, Geocryology--A survey of periglacial processes and environments: New York, John Wiley and Sons, Halsted

White, S. E., 1976, Rock glaciers and block fields, review and new data: Quaternary Research, v. 6, p. 77-97.

Williams, J. R., 1970, Ground water in the permafrost regions of Alaska: U.S. Geological Survey Professional Paper 696, 83 p.



MORAINAL RIDGE

PARENTHESIS--Indicates thin and

GEOLOGIC CONTACT--Dashed where

gradational or inferred

discontinuous deposit above bedrock

(see descriptions for units is, sf, and id)

Interior-Geological Survey, Reston, Va.-1984 For sale by Distribution Section, U.S. Geological Survey, Federal Bldg., Box 12, 101 Twelfth Avenue, Fairbanks, AK 99701, and Branch of Distribution. U.S. Geological Survey, Box 25286, Federal Center, Denver, CO 80225